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INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference AMC043BWO		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/EP 03/05049		International filing date (day/month/year) 14.05.2003	Priority date (day/month/year) 28.06.2002
International Patent Classification (IPC) or both national classification and IPC C01B3/02			
Applicant AMMONIA CASALE S.A. et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 2 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 16.10.2003		Date of completion of this report 19.10.2004	
Name and mailing address of the International preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Van der Poel, W Telephone No. +31 70 340-3760 	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/EP 03/05049**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1-10 as originally filed

Claims, Numbers

9, 10 as originally filed

1-8 received on 05.07.2004 with letter of 29.06.2004

Drawings, Sheets

1/2-2/2 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

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5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-10
	No: Claims	
Inventive step (IS)	Yes: Claims	1-10
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-10
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item I

Basis of the report

1. Some of the amendments do not fulfil the requirements of Article 34(2)(b) PCT.
 - 1.1. Claims 1 and 7 have been amended to define *a plurality* of stages. In the originally application as originally filed, this was defined as *many* stages. Although, both expressions are directed to an indefinite number of stages, there is still a slight difference in scope between the two terms. A *plurality* already includes 2 stages, whereas *many* certainly does not include 2 stages. In the English language, *many* should be compared with *few*, *several*, *some* etc. These terms all encompass a number of more than 1 but are less than *many*.

Subject-matter has been added. For this report, the claims have been interpreted as specifying *many stages*.

- 1.2. Claims 1 and 7 have further been amended to specify that the mixer has an *axially extending portion*, whereas in claims 1 and 7 as originally filed this feature was defined as *a portion...extending for a prearranged axial length*. By deleting the prearranged length from the claim, subject-matter has been added. It is admitted that the term prearranged length is not very clear, which was already indicated in the written opinion, its deletion nevertheless extends the subject-matter claimed. This was also mentioned in the written opinion.

For this report, the claims have been interpreted as specifying the prearranged length of the portion.

2. Claims 1 and 7 have been amended to specify that the mixer has a *decreasing cross section*. In the application as filed, it was mentioned that the mixer had a *reduced cross section*. It is clear from the application as filed that an error had occurred when describing the mixer as having a reduced cross section, because from the references to the figures (and especially to numeral 16a) it was clear that a decreasing cross section was intended (see especially page 7, line 26 - page 8, line 7).

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: Meeting of AIChE 1989, pages 221-233

1. The subject-matter of claims 1 and 7 appears to be novel and involve an inventive step.

Document D1, which is considered to be the closest prior art, discloses a process for the production of ammonia. After the third synthesis gas compressor, a venturi tube is placed in which liquid ammonia is fed into the synthesis gas. This liquid ammonia absorbs water which is present in the synthesis gas. The absorption takes place at around -20°C (see page 227, right hand column, last paragraph).

The use of a venturi tube implies that the process is co-current.

The only difference between claim 1 and document D1, therefore, lies in the place of the venturi. In claim 1 the venturi-like mixer is placed after the first stage of the compressor or after an intermediate stage of the compressor, whereas in D1 the venturi is placed after the third and last stage of the compressor.

The effect achieved by this difference is that the mixer will achieve a higher pressure than the synthesis gas had. This results in more efficient washing of the synthesis gas, while at the same time also compressing the synthesis gas. This means that less compression of the synthesis gas is needed, resulting in the saving of energy.

The problem solved by the application is, therefore, how to make the washing of the synthesis gas with ammonia more efficient.

There is no indication in the prior art to purify synthesis gas from coming from the first stage or an intermediate stage of the compressor.

The subject-matter of claim 1 is novel and involves an inventive step.

For claim 7 directed to the apparatus, the same differences as indicated above for the process are present. The subject-matter of this claim is therefore novel and inventive for the same reasons as specified for claim 1.

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International application No. PCT/EP 03/05049

2. The subject-matter of claims 2-6 and 8-10 is also novel and involves an inventive step, because these claims concern preferred embodiments of claims 1 and 7, respectively.

CLAIMS

1. Method for ammonia production through a catalytic reaction of pressurised synthesis gas in an appropriate compressor with a plurality of stages (1, 2), each of which is equipped with an inlet and outlet (1a, 2a, 1b, 2b, 2c) for said synthesis gas, which method includes a purification step through liquid ammonia of said synthesis gas from water and carbon dioxide contained in it, characterised in that said purification comprises the operating steps of:

- arranging a gas-liquid mixer (16) in fluid communication, on one side with the outlet (1b) of a first stage (1) of said compressor or with the outlet of an intermediate stage thereof and, on the other side, with the inlet (2b) of a stage (2) immediately following said first stage (1) or said intermediate stage, said mixer (16) having an axially extending portion of decreasing cross section,

- axially feeding into said mixer (16) a flow of synthesis gas outbound from said first stage (1) or from said intermediate stage at the same time as a flow of liquid ammonia, said flows being coaxial and in co-current,

- separating substantially anhydrous synthesis gas from the mixture of said flows outbound from said mixer (16) and sending said gas into said stage (2) following said first stage (1) or said intermediate stage.

2. Method according to claim 1, characterised in that said flow of synthesis gas is cooled to a temperature of between +8°/-20°C, before being fed into said mixer (16).

3. Method according to claim 2, characterised in that said cooling is carried out through a flow of liquid ammonia.

4. Method according to claim 3, characterised in that said cooling is carried out upstream of the inlet of said
5 coaxial flows of synthesis gas and of liquid ammonia in said mixer (16).

5. Method according to claim 1, characterised in that said flow of liquid ammonia is fed into said mixer (16) in the form of a plurality of high speed jets.

10 6. Method according to claim 5, characterised in that said flow of liquid ammonia is fed into said mixer (16) making it pass through a nozzle (23) equipped with appropriate suitably sized openings or slits.

7. Apparatus for carrying out the method of claims 1 to 6,
15 comprising a compressor with a plurality of stages (1, 2), each of which is equipped with an inlet and an outlet (1a, 2a, 1b, 2b, 2c), characterised in that it comprises a gas-liquid mixer (16) in fluid communication, on one side with the outlet (1b) of a first stage (1) of said compressor or
20 with the outlet of an intermediate stage thereof and, on the other side, with the inlet (2b) of a stage (2) immediately following said first stage (1) or said intermediate stage, said mixer (16) having an axially extending portion (16a) of decreasing cross-section.

25 8. Apparatus according to claim 7, characterised in that a gas-liquid separator (8) is placed between said mixer (16) and said subsequent stage (2) of said compressor.